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MAC PROJECT 74C-110U

Final Report

IOT&E OF AN AWADS RADAR IMAGERY RECORDER

MAY 1975

MILITARY AIRLIFT COMMAND
OPERATING LOCATION FOXTROT
EGLIN AFB, FLORIDA 32542

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MAC PROJECT 74C-110U

IOT&E OF AN AWADS RADAR IMAGERY RECORDER

IOT&E FINAL REPORT

May 1975

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This report has been reviewed and approved by
Headquarters Military Airlift Command

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MILITARY AIRLIFT COMMAND
OPERATING LOCATION F
EGLIN AIR FORCE BASE, FLORIDA

FOREWORD

MAC Project 74C-110U, IOT&E of an AWADS Radar Imagery Recorder, was conducted under the authority of TAC Project Order 74C-110U. This project was managed in accordance with AFR 80-14 and TACR 55-10. Active testing was accomplished at Pope AFB, North Carolina, from 3 to 18 February 1975. All active testing was supervised by HQ MAC OL F personnel.

The following personnel were responsible for the conduct of the project:

HQ MAC OL C Project Officer	D. R. HENDRICKSON, Lt Col, USAF HQ MAC OL C
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The assistance of the following organizations is gratefully acknowledged:

USAF Tactical Air Warfare Center
Aeronautical Systems Division
4th Tactical Fighter Wing
317th Tactical Airlift Wing
363d Tactical Reconnaissance Wing

SUMMARY

MAC Project 74C-110U was conducted to evaluate the prototype adverse weather aerial delivery system radar imagery recorder installed in a C-130 aircraft. The primary purpose of the project was to determine the operational effectiveness and suitability of the prototype recorder system for use in navigator ground training, radar prediction, and reconnaissance/intelligence gathering. Specific objectives were to determine whether the system provides imagery of such quality that radar returns are readily identifiable, whether the system can be installed in the aircraft without hindering operations, and the operational suitability of the navigator-operated controls. Additional specific objectives were to determine whether the system can record all range marks, heading marks, and cursors; whether the system records sufficient information to identify aircraft location; and whether the system is capable of operating at altitudes up to and including 25,000 feet above mean sea level with the aircraft pressurized and unpressurized.

It was concluded that the prototype system is operationally effective and suitable for use in navigator training and radar prediction and has limited capability as a reconnaissance/intelligence-gathering device. The system provides imagery of such quality that radar returns selected for use as en route checkpoints and target area offset aiming points are readily identifiable. The navigator-operated controls for the recorder system are operationally suitable; however, the overall system in its present configuration hinders normal operations but does not prevent accomplishment of required tasks. The system records all range marks, heading marks, and cursors essentially as presented on the navigator's radar indicator. The prototype system records sufficient information to identify aircraft position from the reproduced image and is capable of operating at altitudes up to and including 25,000 feet above mean sea level with the aircraft both pressurized and unpressurized. The navigator's radar indicator mount, however, does not satisfy the 16-G-force forward crash condition as specified in the Aeronautical Systems Division approved Class II modification package; and some improvements to the auxiliary data block are required.

It is recommended that the prototype radar imagery recorder be considered for operational use as an aid to navigator ground training and radar prediction. It is further recommended that action be taken to make specific improvements to the recorder system. After incorporation of improvements, the system should be operationally tested and evaluated during aerial delivery operations.

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ILLUSTRATIONS

TABLES

ABBREVIATIONS

AGL . . . . above ground level
ASD . . . . Aeronautical Systems Division
AWADS . . . . adverse weather aerial delivery system
IOT&E . . . . initial operational test and evaluation
LEDS . . . . light-emitting diodes
MAC . . . . Military Airlift Command
mm . . . . millimeter
MSL . . . . mean sea level
OAP . . . . offset aiming point
ROC . . . . required operational capability

IOT&E FINAL REPORT

MAC PROJECT 74C-110U

IOT&E OF AN AWADS RADAR IMAGERY RECORDER

1. INTRODUCTION.

a. Operational Requirement. The adverse weather aerial delivery system (AWADS) utilizes a Ka-band radar system to obtain precise fixes during tactical en route and airdrop operations. In order to obtain the accuracy required for the AWADS mission, extensive navigator airborne radar training must be accomplished. The navigator is required to study the target area radar presentation prior to the mission. Aids provided the navigator include radar prediction and intelligence estimates concerning the target area. A Military Airlift Command required operational capability (MAC ROC 320-73) states the requirement for a radar imagery recording device modified to fit the AWADS radar that can provide radar imagery to be used for navigator ground training, radar prediction, and reconnaissance/intelligence data-gathering purposes.

b. Operational Concept. The radar imagery recording device will be employed during C-130 tactical en route and airdrop operations to provide an accurate pictorial record of radar imagery for navigator ground training and realistic radar predictions. Additionally, it may be used to enhance intelligence estimates for combat operations.

c. Hardware Description. Aeronautical Systems Division (ASD) has designed and fabricated a prototype radar imagery recording system. The system includes an O-15 camera, necessary modifications to the navigator's table and radarscope to allow installation of the camera, and an auxiliary data block for recording mission data on 35-millimeter (mm) motion picture film. Recorded mission data include date, time, navigator identification, airdrop zone, magnetic heading, ground speed, true airspeed, track angle, cursor motion, radar range, compass selected, mean sea level (MSL) altitude, cursor azimuth, cursor range, radar update, airdrop warning status, offset aiming point (OAP), and film frame number. A detailed description of the system is provided in Annex A.

2. PURPOSE OF THE IOT&E. The overall purpose of the project was to determine the operational effectiveness and suitability of the prototype AWADS radar imagery recorder system for use in navigator ground training, radar prediction, and reconnaissance/intelligence gathering.

a. Scope. AWADS-qualified maintenance personnel assisted ASD engineering personnel with the installation of the AWADS radar imagery recorder system in a C-130 aircraft. The ASD personnel performed electromagnetic compatibility tests and ground checks of the installation. Flight tests were conducted at altitudes from 500 feet above ground level (AGL) to 25,000 feet MSL. A total of 10 navigators participated in the flight testing to obtain an objective and independent evaluation of the prototype system.

b. Critical Questions and Issues. Not applicable.

c. Specific Objectives. The specific objectives were as follows:

(1) Determine whether the recorder system provides imagery of such a quality that the radar returns selected for use as en route checkpoints and target area OAPs are readily identifiable.

(2) Determine whether the recorder system can be installed in the C-130 aircraft without hindering operations.

(3) Determine the operational suitability of the navigator-operated controls for the recorder system.

(4) Determine whether the system will record all range marks, heading marks, and cursors as presented on the navigator's radar indicator.

(5) Determine whether the system records sufficient information to identify aircraft location from the reproduced image.

(6) Determine whether the recorder system is capable of operating at altitudes up to and including 25,000 feet MSL with the aircraft both pressurized and unpressurized.

3. METHOD OF ACCOMPLISHMENT.

a. IOT&E Environment.

(1) Prior to active testing, an aircraft simulator was designed and used by ASD engineers to exercise the prototype system. Cable interconnections and structural and electrical interfaces were also developed at this time.

(2) Upon arrival at Pope AFB, North Carolina, and prior to aircraft installation, the system was installed on a field training detachment AWADS simulator to further check compatibility with the AWADS. Problem areas associated with the interface were identified and are discussed later in this report.

(3) The 317th Tactical Airlift Wing provided one C-130 AWADS-equipped aircraft as a test bed for the prototype system. Installation

and ground checking of the interface with the aircraft were accomplished by ASD engineers with the assistance of 317th Tactical Airlift Wing AWADS-qualified maintenance personnel.

(4) Six missions consisting of 11 sorties were flown in the Pope AFB local area under controlled test conditions from 10 to 18 February 1975 to achieve test objectives. Known checkpoints and OAPs were used by the 10 navigators to provide independent evaluations of the prototype system. Three of the navigators were also qualified weapons and tactics officers. Table 1 provides a test mission summary. All flights were made on the modified C-130 aircraft. At the end of each mission, film was flown directly to Seymour Johnson AFB, North Carolina, for immediate processing. Upon return to Pope AFB, debriefings were conducted at the 317th Tactical Airlift Wing Weapons and Tactics Office, and included film analysis of radar imagery by participating navigators and test management personnel. Prints of selected frames were made for analysis of the radar imagery and auxiliary data.

b. Method of Test and Evaluation. Each sortie was flown at a preselected altitude with a different navigator/weapons and tactics officer except for sorties 3 and 10, which utilized the same navigator. As shown in Table 1, flight altitudes ranged from 500 feet AGL to 25,000 feet MSL. A physiological training supervisor participated on all sorties conducted at 25,000 feet MSL. Missions were flown over preselected routes. Nine sorties were terminated with airborne radar approaches. Test navigators selected radar update points and OAPs in flight from those that were prebriefed during mission preparation. En route position coordinates were recorded on a data form, along with the level of intensity/gain used. The camera/periscope assembly mounted on the navigator's indicator (Figure 1) recorded the radar display and auxiliary data throughout the mission. Debriefings included review and analysis of the recorded imagery and were attended by test navigators, weapons and tactics officers, imagery interpreters, operations analysts, and intelligence and test management personnel. Each attendee provided comments and recommendations relative to his area of expertise. Test management personnel recorded and documented pertinent comments and recommendations. Following the film analysis during debriefings, navigator questionnaires were completed to determine the quality of recorded radar imagery in comparison to what was observed during flight.

4. RESULTS AND DISCUSSION.

a. Operational Suitability.

(1) Capability To Fulfill Requirement. MAC ROC 320-73 states a requirement for a radar imagery recording device modified to fit the AWADS radar that can provide radar imagery to be used for navigator ground training, radar prediction, and reconnaissance/intelligence-gathering purposes.

Table 1. Mission Summary

Msn No.	Sortie No.	Date Completed (1975)	Navigator Ident No.	Altitude Flown (feet)	Route	ARAs Flown	Flight Time (hours)
1	1	10 Feb	01	500 AGL	411 VFR	Yes	2.5
	2	10 Feb	02	1,000 AGL	411 VFR	Yes	2.5
2	3	11 Feb	03	10,000 MSL	Pope IFR	Yes	2.7
	4	11 Feb	04	17,900 MSL	Pope IFR	Yes	2.8
3	5	12 Feb	05	2,000 AGL	Pope IFR	Yes	2.5
	6	12 Feb	06	10,000 MSL	Pope IFR	Yes	2.5
4	7	13 Feb	07	1,000 AGL	411 VFR	Yes	2.5
	8	13 Feb	08	17,900 MSL	Pope IFR	Yes	2.6
5	9	14 Feb	09	25,000 MSL	Pope IFR	No	2.7
6	10	18 Feb	03	25,000 MSL	Pope IFR	No	1.8
	11	18 Feb	10	25,000 MSL	Pope IFR	Yes	1.9
						Total	27.0

NOTES:
1. Holland drop zone was used on all missions.
2. Parts of sortie 5 were flown at 3,000 and 4,000 feet to correspond with the Pope AFB training profile.
3. Sortie 9 was aborted because of a radar failure inside the 1-minute warning.

ABBREVIATIONS:
ARA - airborne radar approach
Ident - identification
IFR - instrument flight rules
Msn - mission
VFR - visual flight rules

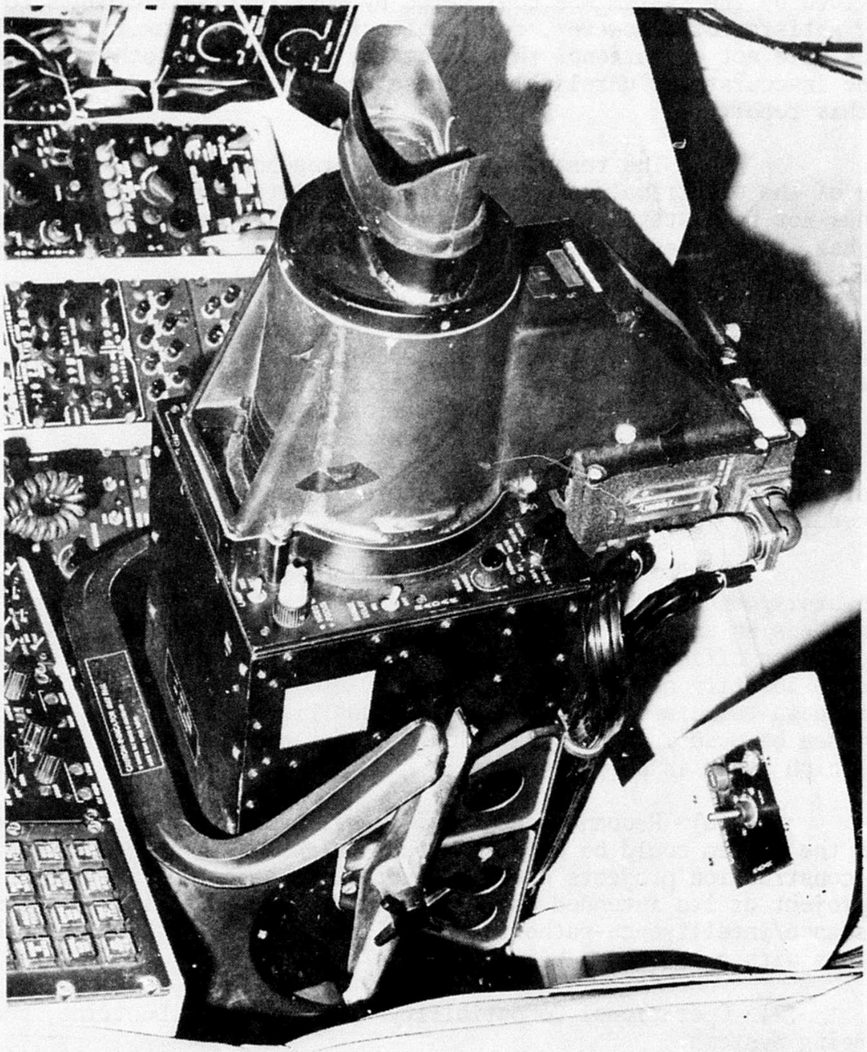

Figure 1. Radar Indicator and Camera/Periscope Assembly.

(a) The imagery recorder that evolved through the course of the IOT&E was considered to be operationally suitable in most functional areas prior to the end of active testing. The photography provided by the system was considered by most test participants to be very satisfactory; however, certain functions of the auxiliary data block were not operational throughout the testing, and others proved to be inaccurate or unreliable. These are discussed in detail later in this report.

(b) The tested system is a breadboard prototype, and many of the electrical components are not military standard items. It has not been static-tested for operation at extreme temperatures, nor has it been tested for tolerance to vibration or altitude except as encountered during the active flight phase.

(c) Results of the flight phase indicate that the system is capable of providing imagery suitable for use in navigator training. Nine of 10 navigators/weapons and tactics officers agreed that the system accurately records what is portrayed on the navigator's indicator (see Figure 2). It was also generally agreed by the test participants that recorded imagery could aid students in improving their radarscope interpretation, airdrop scores, and airborne radar approach procedures.

(d) A similar response was obtained from the participating navigators/weapons and tactics officers with respect to the system's usefulness as an aid to radar prediction. Nine test navigators/weapons and tactics officers were of the opinion that films of routes can be used to identify new update points and OAPs, which are then compared with known targets on maps and charts (see Figure 3). This procedure may then be used in the preparation of radar predictions of targets for which there is no photography.

(e) Reconnaissance and intelligence specialists agreed that the system could be used to detect targets such as roads, runways, and construction projects but would not suffice to identify the type of project or its intended use. This system provides limited reconnaissance/intelligence-gathering capability; however, there are other systems with greater capability in this area.

(2) Operational Compatibility With Concepts, Doctrine, and In-Being Systems.

(a) Concepts and doctrine. The basic concept of the AWADS radar imagery recorder is to provide recorded imagery to be used for navigator training, radar prediction, and reconnaissance/intelligence purposes. Specifically, the operational concept is to reduce the amount of navigator flight training required and to provide

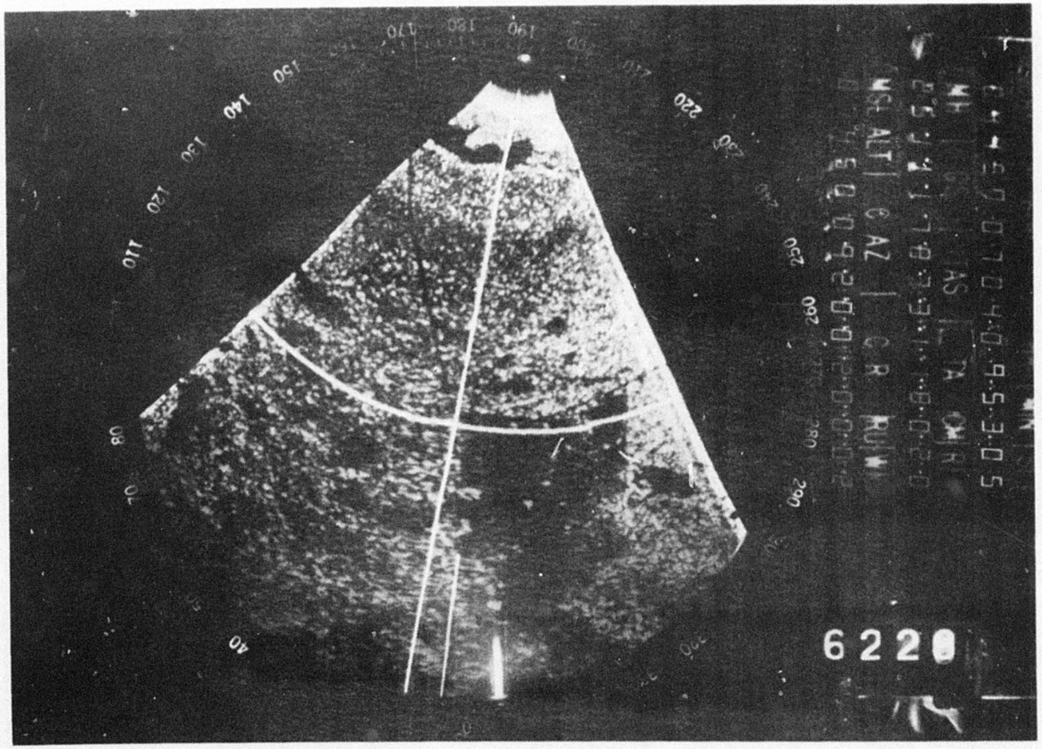

Figure 2. Navigator's Indicator and Auxiliary Data Block.

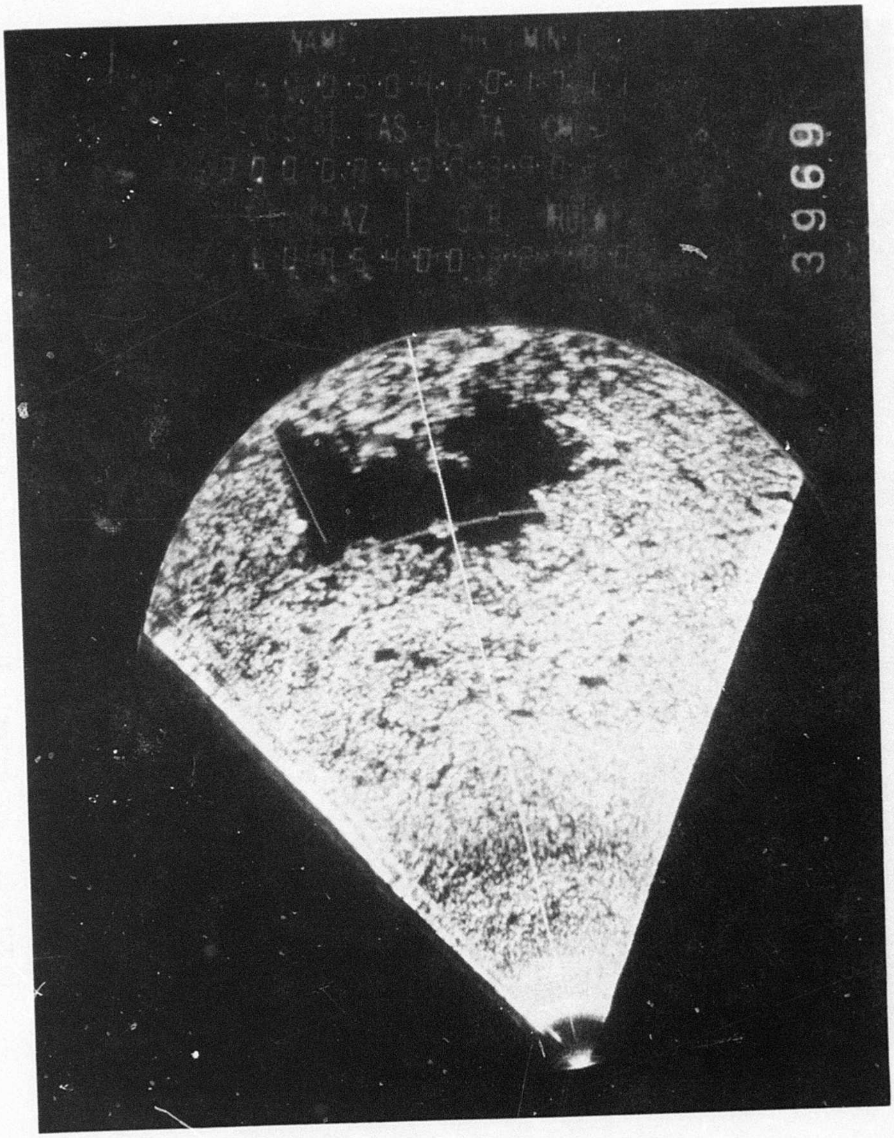

Figure 3. Navigator's Indicator Showing Newly Constructed Lake.

aircrews with more accurate and reliable radar information for a given mission profile. The imagery recorder is compatible with Air Force tactical airlift concepts and doctrine related to employment characteristics, operations, and principles as delineated in AFM 2-4.

(b) In-being systems. The imagery recorder was determined to be operationally compatible with the C-130 aircraft, the AWADS, and current procedures for aerial delivery operations at altitudes from 500 feet AGL to 25,000 feet MSL.

1. Electromagnetic compatibility tests conducted by ASD personnel were satisfactory.

2. ASD analysis of the system indicates that the aircraft structure affected by the installation of the recorder system (specifically, the navigator's radar indicator mount) will not sustain a 16-G-force forward crash condition. This requirement is implied in the ASD approved Class II modification package for the C-130 AWADS radar imagery recorder. The problem was solved during the IOT&E by the temporary installation of a cable and anchor assembly (see Figure 4). This solution is probably not feasible for Class V modification because the cable passes through the navigator table work area. Permanent installation of the system in the aircraft may require relocation of the navigator's indicator and/or modification of the indicator mount to satisfy the 16-G-force forward crash condition.

3. Seven of nine responding test navigators stated that the navigator-operated camera controls were operationally suitable. Two navigators remarked that the location (on the upper crew bunk) was somewhat inconvenient (see Figure 5). The navigator-operated controls will not be located on the upper crew bunk in the Class V modification.

4. No problem was encountered in either loading or unloading the film magazine in flight. Either function required 10-30 seconds to perform. All navigators/weapons and tactics officers felt that the recording time per magazine (80 minutes) was adequate to accomplish the mission.

5. Eight of 10 test navigators stated that the installation hindered inflight operations to a degree. From a suitability standpoint, several undesirable characteristics were noted.

a. Installation of the camera/periscope assembly effectively reduces the navigator table work area by approximately 44 percent (see Figure 6). This does not adversely affect the normal tactical aerial delivery mission; however, overwater flights require considerably more work space to accommodate such equipment as large maps, charts, and plotters. The installation in its present configuration will limit the available work space.

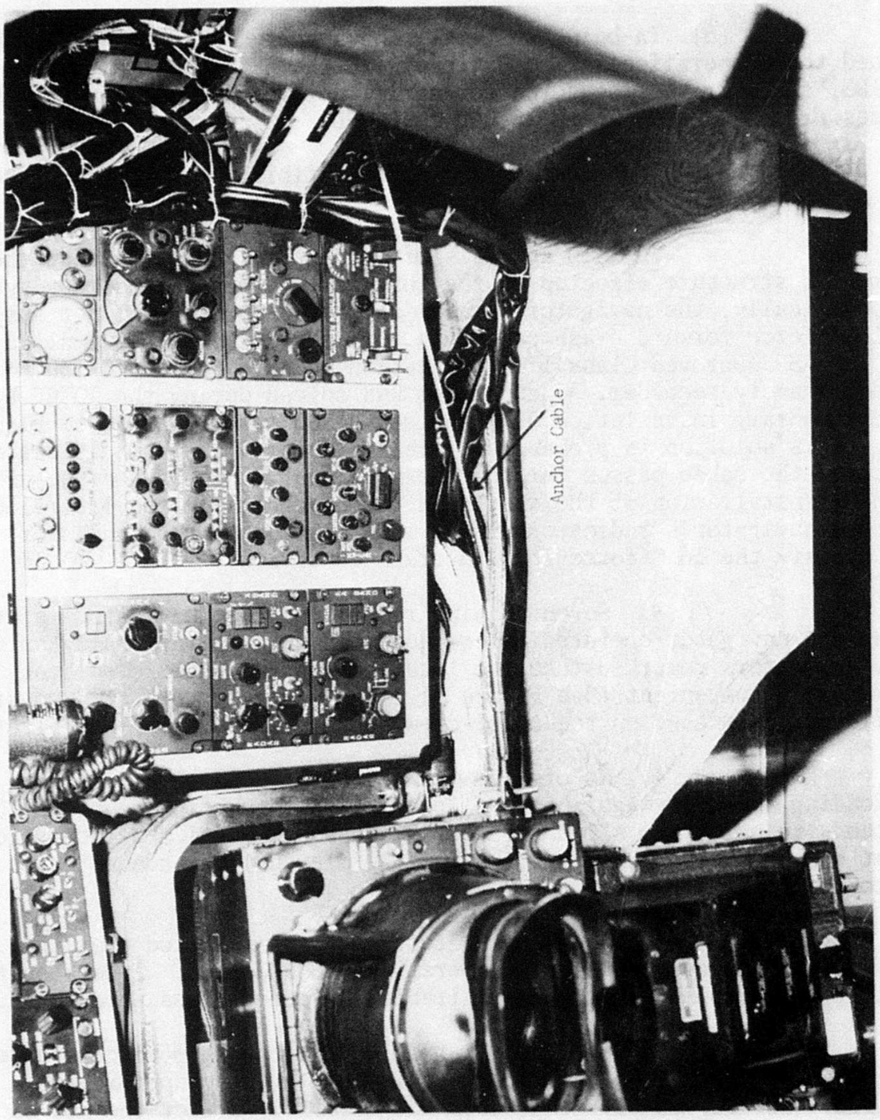

Figure 4. Temporary Cable and Anchor Assembly.

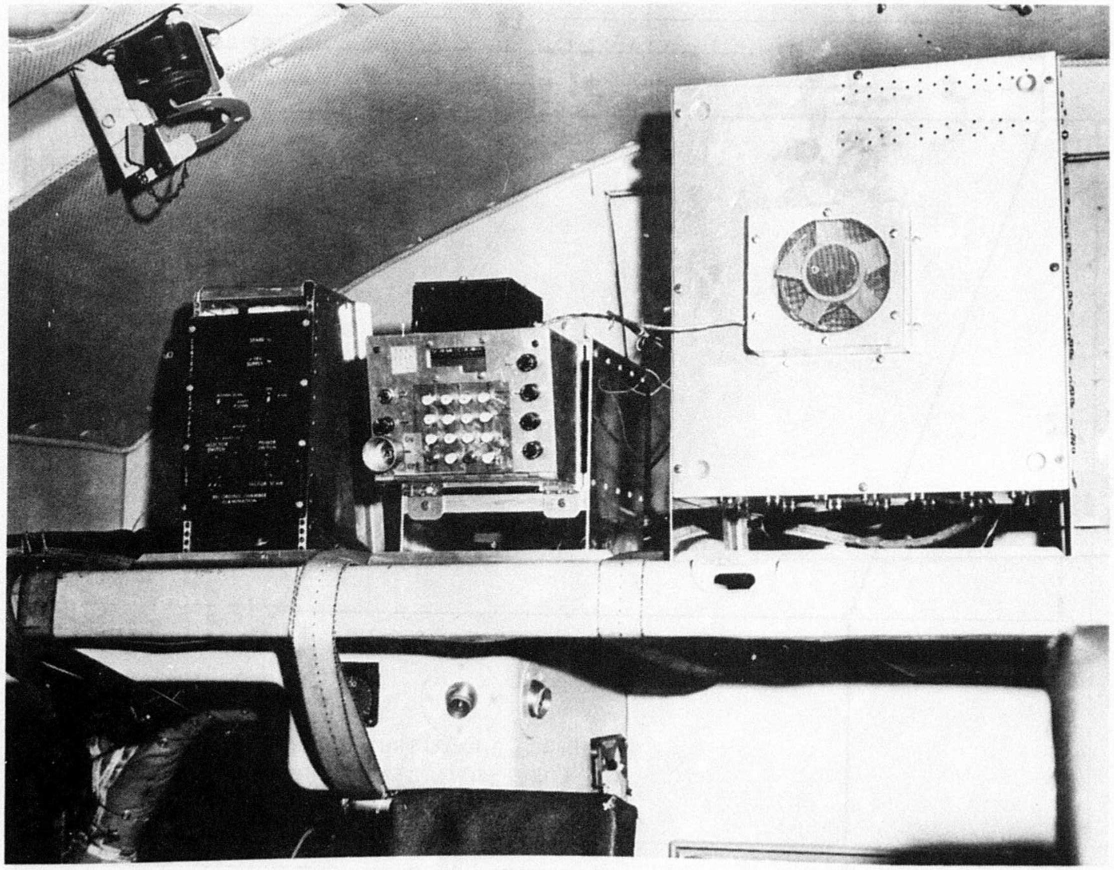

Figure 5. Navigator-Operated Controls Located on Upper Crew Bunk.

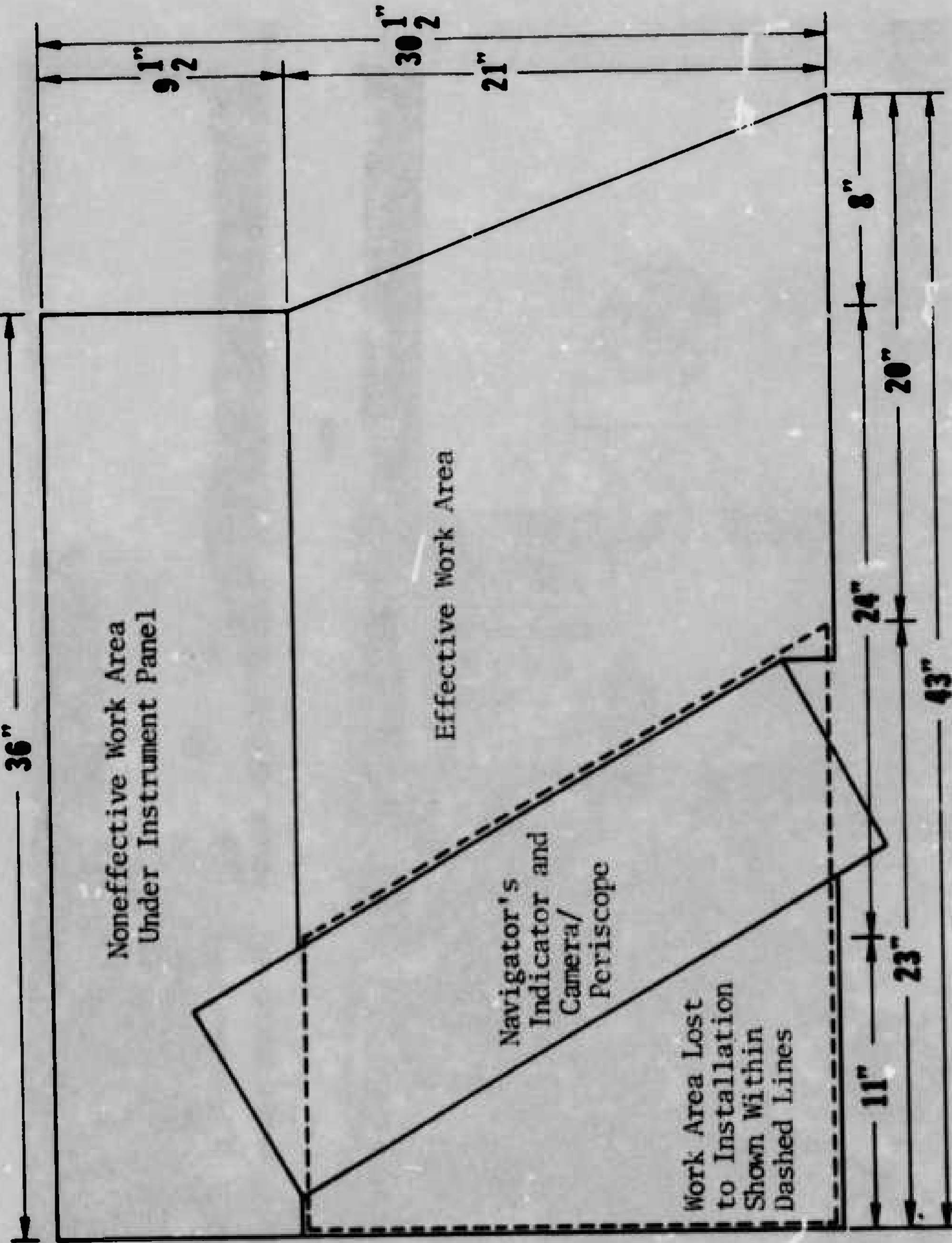

Figure 6. Analysis of Navigator Table Work Area.

b. In its present configuration, adjustment of the navigator's indicator in the vertical plane is limited to approximately 2 1/2 inches. This limitation and the protrusion of the camera/periscope assembly cause some difficulty for tall navigators. They are required to assume a somewhat awkward position to view the video portrayed on the indicator.

c. The protrusion of the camera/periscope assembly also causes difficulty for some navigators in that the radar and antenna controls are difficult to reach while viewing video on the navigator's indicator. The distance from the periscope to the radar controls is 25 inches (see Figure 7). Navigators with short arms experienced difficulty making adjustments while viewing the indicator (see Figure 8). This condition may be minimized by reducing the physical size of the periscope.

d. The protrusion of the camera/periscope assembly causes additional difficulties in viewing and tuning the radar and programming the AWADS computer in flight when the oxygen mask is worn at high altitudes (see Figure 9). Again, a reduction in the size of the periscope may minimize this condition.

e. These undesirable characteristics do not prevent accomplishment of normal navigator tasks. They do, however, increase the level of difficulty of accomplishing some tasks and thereby hinder normal operations.

(3) Operational Implications.

(a) Personnel/training requirements. The employment of the imagery recorder will not adversely impact on current personnel and training requirements. Navigators will require a short ground indoctrination on the operation of the system, but this may be accomplished as part of the AWADS Phase II upgrade training. The eventual effect may be a reduction in the amount of Phase II flight training required.

(b) Flight manuals. Employment of the imagery recorder will require changes to flight manuals. The Class V modification may require some structural modification of the navigator's indicator mount and navigator table. Relocation of some navigator equipment may be necessary. Documentation of any relocated equipment will be required. Also, minor changes to the navigator checklist will be required to include operation of the imagery recorder. Annex B contains preliminary instructions for operation of the recorder system.

(c) Flight safety. Electromagnetic compatibility tests were determined to be satisfactory by ASD personnel prior to flight testing. Preliminary stress analysis conducted by ASD personnel prior to the Class II modification required temporary installation of a cable

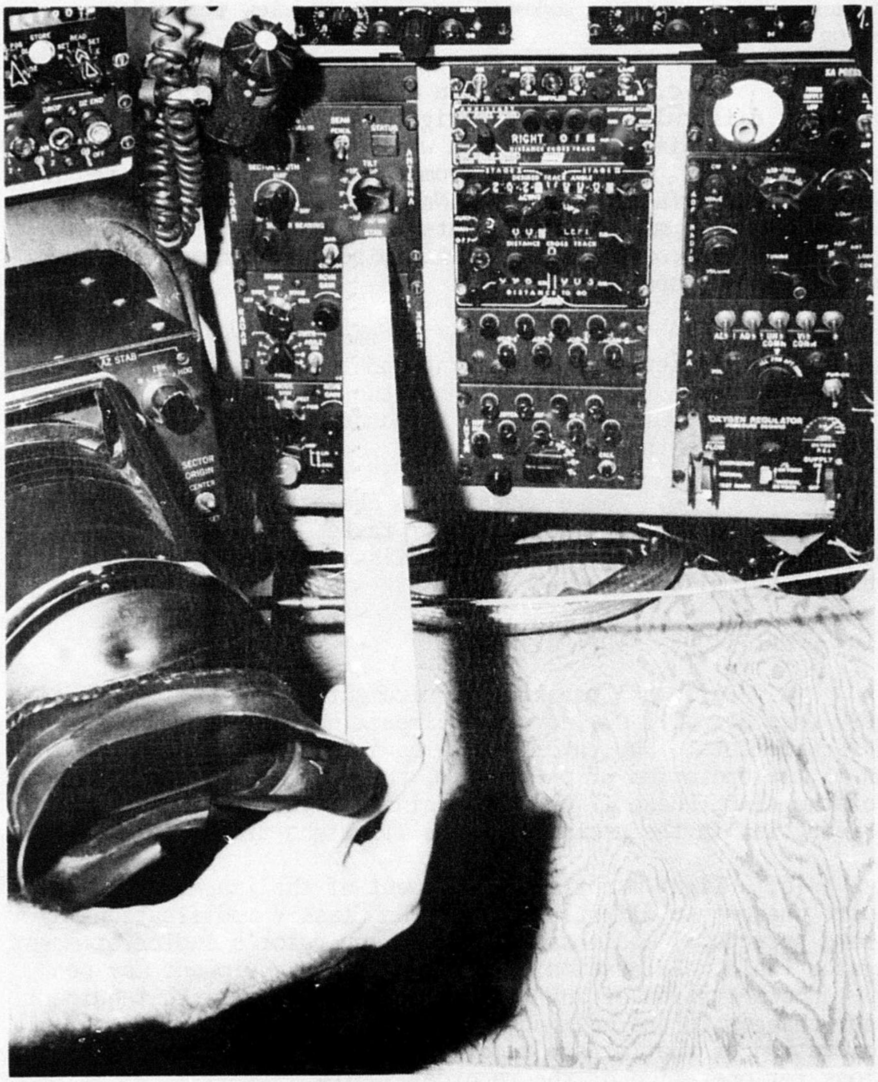

Figure 7. Distance From Periscope to Antenna Control.

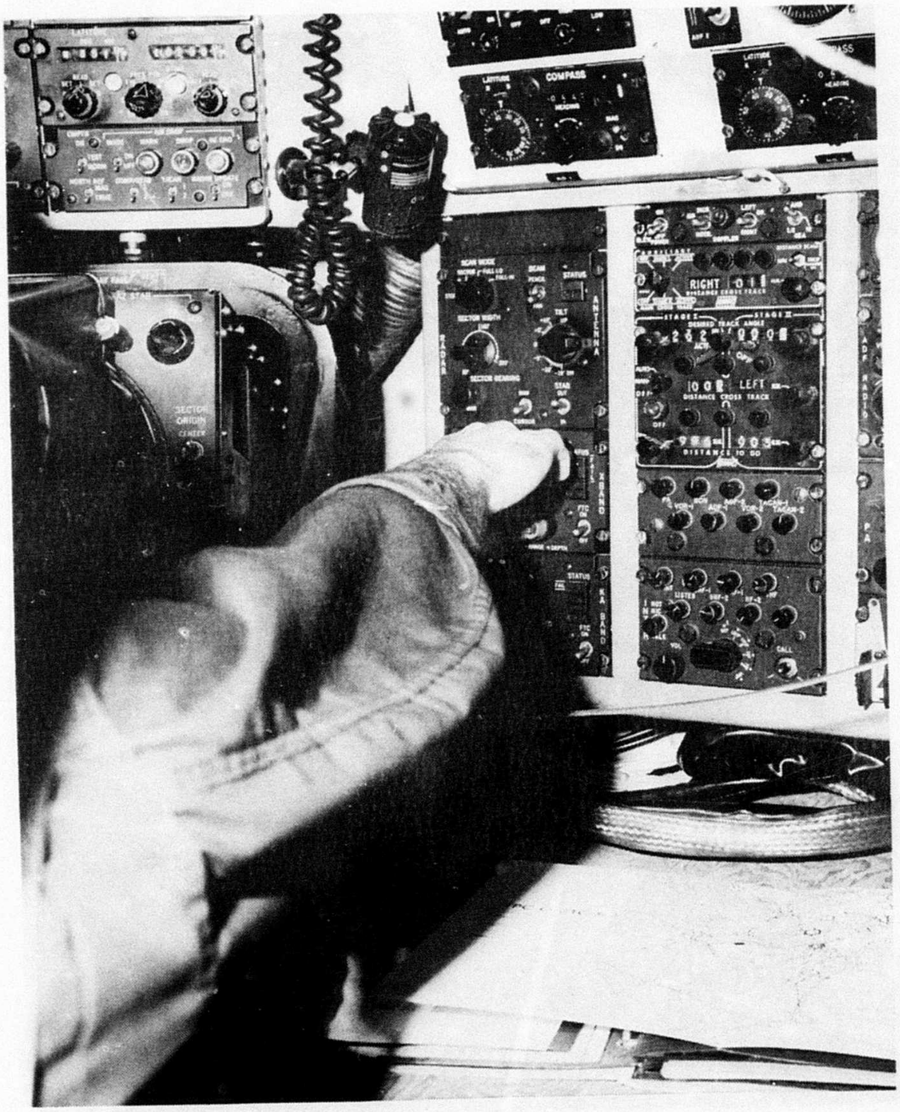

Figure 8. Long Reach Required To Make Tuning Adjustments.

Figure 9. Periscope/Oxygen Mask Interference While Programming Computer.

and anchor assembly to restrain the navigator's indicator in the event of a forward crash condition. It was generally agreed by test participants that this cable and anchor assembly would not be acceptable for Class V modification. This will necessitate relocation of the navigator's indicator and/or modification of the indicator mount as discussed in paragraph 4a(2)(b)2.

(4) Logistical Supportability.

(a) Special facilities. Although specific details cannot be identified at this time, any Class V modification must include provisions and equipment for film, film storage, film loading, and film processing and printing.

(b) Maintainability. Maintainability could not be accurately determined because of the relatively small number of missions (six). As mentioned earlier, many electrical components of the prototype are not military standard items. During the conduct of the flight testing, one failure of the recorder was experienced during a preflight check when a 6-ampere fuse on junction box A was blown for unknown cause. Additionally, one AWADS radar indicator failure and one AWADS signal data converter failure were experienced. These failures were not attributable to the recorder system installation.

(c) Support and test equipment. Two items of support and test equipment are required and are listed in Table 2.

Table 2. Required Support and Test Equipment

Quantity	Equipment	Function
1	Simulator, radar signal, LM-24(1)	To provide simulated radar inputs to exercise and check the O-15 camera and LD-6 control
1	Simulator, aircraft/computer signal	To provide simulated aircraft and AWADS computer inputs to exercise and check the auxiliary data block and keyboard entry control functions

NOTES:
1. The LM-24(1) radar signal simulator is contained in the Government inventory.
2. The aircraft/computer signal simulator is not contained in the Government inventory.

(d) Personnel/training requirements. Training of maintenance personnel on the imagery recorder system will be required. It is anticipated that this will fall into the AWADS radar/computer category and may be accomplished at the field training detachment level. Maintenance of the O-15 camera may require addition of an aerospace photo repairman, AFSC 404X1, to the unit detail listing.

(e) Technical manuals. Procedures for maintaining the imagery recorder should be documented in the appropriate technical orders and technical manuals.

(f) Mobility. Logistical support requirements for the imagery recorder system will not substantially change when the system is deployed. Film processing and system maintenance will continue to be a requirement regardless of the location of the aircraft.

(g) Ground safety. No ground safety hazards were identified. Normal safety precautions associated with C-130 electrical maintenance should be observed.

b. Operational Effectiveness.

(1) Capability To Perform Required Missions, Functions, and Tasks in an Operational Environment. Use of an imagery recording system during tactical aerial delivery operations was proved to be feasible. The results achieved during testing support this concept.

(a) The recorder system demonstrated the capability to record radar imagery of such quality that en route checkpoints and target area OAPs were readily identifiable (see Figure 10). All test participants readily recognized checkpoints and OAPs from the imagery provided.

(b) All range marks, heading marks, and cursors were recorded. When high levels of intensity were used, the system tended to record a secondary reflection as well as the primary image (see Figure 11). This resulted in a slight double-image problem when high levels of range mark, cursor, and heading mark intensity were used. The problem can be easily solved by lowering the intensity of range marks, cursors, and heading marks.

(c) Aircraft position was easily determined from the recorded imagery. By using cursor range and cursor azimuth supplied by the auxiliary data block, aircraft position relative to a known checkpoint may be plotted on a navigation chart. This was done for all sorties by test management personnel. Aircraft position as recorded on the film differed by an average of 0.12 nautical mile from the AWADS computer position coordinates. This difference may be attributed to navigator delays in recording the computer coordinates after an update had been accomplished or minor chart and plotting inaccuracies. This difference is considered to be negligible.

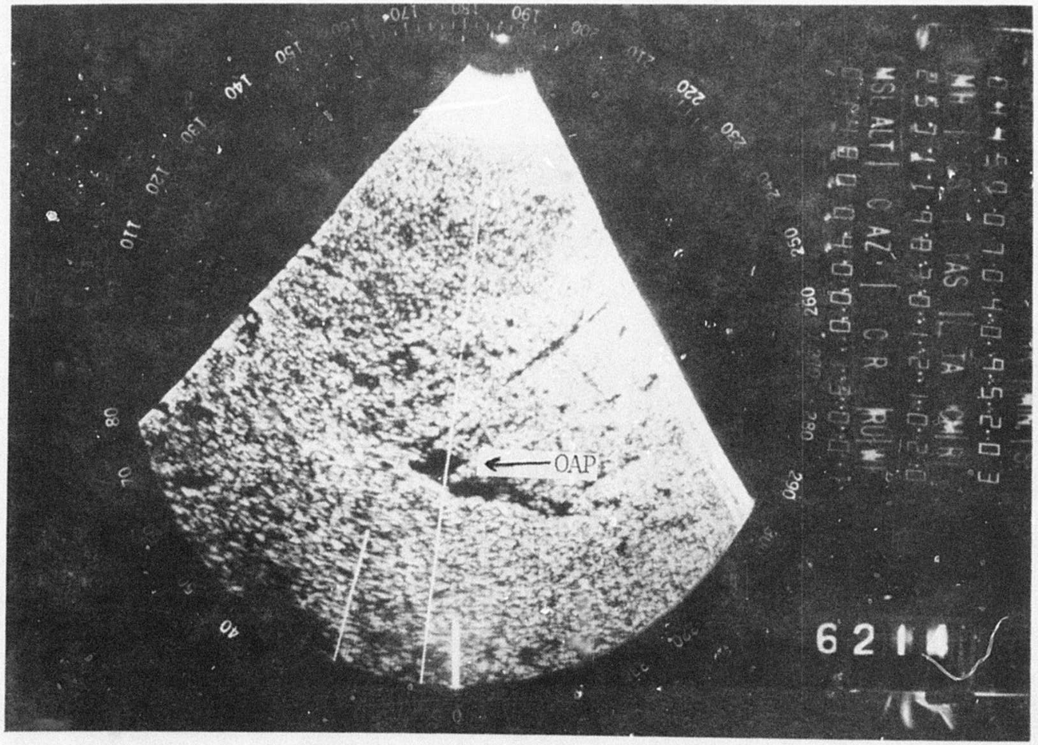

Figure 10. OAP Visible on Photograph.

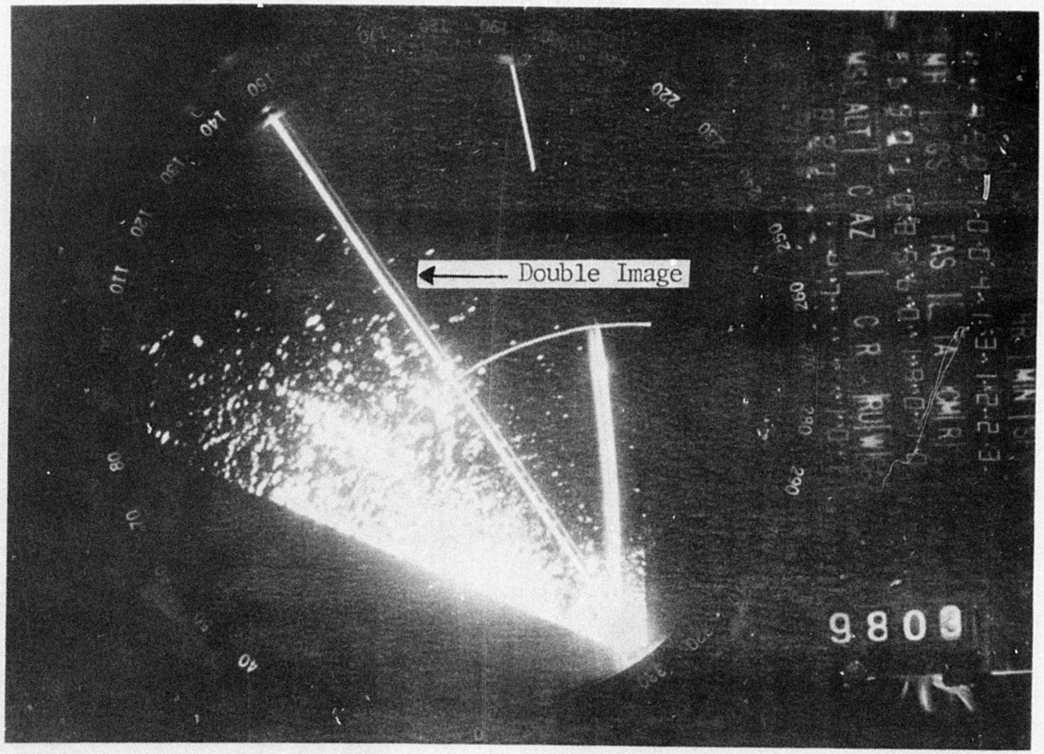

Figure 11. Double Cursor Image.

(d) The system performed satisfactorily at altitudes up to and including 25,000 feet MSL with the aircraft both pressurized and unpressurized. Table 1 shows sorties and altitudes flown. There were no recorder system failures during actual inflight testing. The one failure mentioned earlier occurred during a preflight check and was remedied by replacing a 6-ampere fuse on junction box A.

(2) Comparative Effectiveness.

(a) TAC Project 72A-100T was a follow-on OT&E of an AWADS radar data recorder which employed an optical scan converter and a video tape recorder. It was concluded that the radar imagery provided by that system was ineffective because of lack of contrast, excessive blooming, poor definition, poor resolution, and inadequate recording time (45 minutes). The system was considered to be unsatisfactory for use in navigator training, radar prediction, and identification of OAPs.

(b) The AWADS radar imagery recorder described in this test provides imagery essentially as portrayed on the navigator's indicator. Recording time per magazine is 80 minutes based on a frame exposure rate of one frame every 3 seconds. In addition, the system is capable of providing 20 items of auxiliary information through the auxiliary data block. The previously tested AWADS radar data recorder discussed in the preceding paragraph did not have this capability.

c. Operational Limitations. Specific requirements for the system in the area of reconnaissance/intelligence gathering have not been identified. As a result, the reconnaissance/intelligence-gathering capability was considered in very broad and general terms. There are conceivable situations (where very little or no valid data are available) in which the information provided by the system would be of significant value outside the tactical airlift environment; however, there are other sensing systems that are specifically designed for reconnaissance purposes. The AWADS and the associated radar imagery recorder cannot favorably compete with these systems, and for this reason, the tested system is considered to be operationally limited in the reconnaissance/intelligence area.

d. System Deficiencies. Although not considered to be operational limitations, the following system deficiencies were documented during the course of the IOT&E.

(1) Auxiliary Data Block. Several discrepancies were associated with the auxiliary data block and are shown in Table 3. Most of these discrepancies resulted because of a lack of accurate AWADS technical data available to ASD design engineers. When the system was interfaced with the AWADS during ground installation and checkout, many functions of the auxiliary data block were discovered to be erroneous or inoperative. Although redesign of the interface corrected

Table 3. Auxiliary Data Block Functional Analysis.

Auxiliary Data	Code	Functional Analysis
Day, year	DAY YR	Provided accurate data but brightness of light-emitting diodes caused undesirable glare on film and photography
Navigator's coded name	NAME	Provided accurate data and operated satisfactorily
Drop zone	DZ	Provided accurate data and operated satisfactorily
Time	HR MIN SEC	Provided accurate data and operated satisfactorily
Magnetic heading	MH	Provided accurate data except when aircraft was in a turn
Ground speed	GS	Provided accurate data and operated satisfactorily
True airspeed	TAS	TAS had a constant error of approximately 700 knots throughout testing
Track angle	TA	Provided accurate data and operated satisfactorily for first six sorties; thereafter, had a constant error; readout was one-half actual value
Cursor motion	CM	Inoperative because of nonavailability of necessary electrical component
Radar range	R	Inoperative for first four sorties; thereafter, provided accurate data and operated satisfactorily
Compass selected	C	Intermittently provided erroneous information
Mean sea level altitude	MSLALT	Provided accurate data except when aircraft was climbing or descending
Cursor azimuth	CAZ	Provided accurate data and operated satisfactorily
Cursor range	CR	Provided accurate data and operated satisfactorily
Radar update	RU	Had a constant readout indicating radar update ON for first six sorties; thereafter, provided accurate data and operated satisfactorily
Airdrop warning control	W	Inoperative because of nonavailability of necessary electrical component
Offset aiming point	OA	Inoperative for first two sorties; thereafter, provided accurate data and operated satisfactorily

some of the deficiencies, there was not enough time or parts available to correct all discrepancies prior to the end of active testing. Since the recorder system receives its inputs by instantaneously sampling the AWADS computer information, magnetic heading and MSL altitude are subject to significant errors any time the aircraft is turning, climbing, or descending. This is definitely an undesirable condition. It was suggested to ASD personnel that an absence of heading and altitude information during turns, climbs, and descents would be preferable to erroneous information, which may be difficult to verify or rule out. ASD engineers believe it to be feasible to incorporate circuitry that will blank out heading and altitude readings during turns, climbs, and descents. Also, it is considered feasible to sample the computer altitude and heading information at a different point in the computer cycle and receive the averaged value that the computer is using for its computations. Subsequent conversations with ASD personnel indicate that from a technical standpoint all auxiliary data block discrepancies listed in Table 3 can be corrected.

(2) Physical Installation. The undesirable characteristics associated with the physical installation were discussed in paragraph 4a(2)(b)5.

5. INTEGRATION INTO FORCE STRUCTURE. Integration into the force structure is not applicable to this report.

6. CONCLUSIONS. Page and paragraph references listed below contain supporting data relating to each conclusion.

a. The prototype AWADS radar imagery recorder is operationally effective and suitable for use in navigator ground training and radar prediction and has limited capability as a reconnaissance/intelligence-gathering device (page 3, paragraph 4).

b. The recorder system provides imagery of such quality that radar returns selected for use as en route checkpoints and target area OAPs are readily identifiable (page 18, paragraph 4b(1)(a)).

c. The recorder system in its present configuration hinders normal operations but does not prevent accomplishment of required tasks (page 9, paragraph 4a(2)(b)5).

d. The navigator-operated controls for the recorder system are operationally suitable (page 9, paragraph 4a(2)(b)3).

e. The system records all range marks, heading marks, and cursors essentially as presented on the navigator's radar indicator (page 18, paragraph 4b(1)(b)).

f. The system records sufficient information to identify aircraft position from the reproduced image (page 18, paragraph 4b(1)(c)).

g. The recorder system is capable of operating at altitudes up to and including 25,000 feet MSL with the aircraft both pressurized and unpressurized (page 21, paragraph 4b(1)(d)).

h. The navigator's radar indicator mount does not satisfy the 16-G-force forward crash condition as specified in the ASD approved Class II modification package when the camera/periscope assembly is attached (page 9, paragraph 4a(2)(b)2).

i. Specific improvements to the auxiliary data block are required (page 21, paragraph 4d(1)).

7. RECOMMENDATIONS. It is recommended that:

a. The prototype AWADS radar imagery recorder be considered for operational use as an aid to navigator ground training and radar predictions.

b. Action be taken to investigate the feasibility of decreasing the physical size of the camera/periscope assembly to enhance system compatibility with the AWADS-configured C-130 aircraft and normal navigator tasks.

c. Action be taken to investigate the feasibility of relocating and/or modifying the navigator's indicator mount to satisfy the 16-G-force forward crash condition as discussed in paragraph 4a(2)(b)2, if required.

d. Action be taken to correct the auxiliary data block discrepancies discussed in paragraph 4d(1).

e. The recorder system be operationally tested and evaluated during aerial delivery operations after incorporation of improvements.

ANNEX A

DESCRIPTION OF TEST ITEM

1. BACKGROUND. The O-15 camera was chosen for use with the AN/APQ-122(V)1 radar in the C-130 aircraft because sufficient repairable cameras and LD-6 camera controls for an AWADS Class V modification are presently in the Air Force inventory.

2. CAMERA/PERISCOPE ASSEMBLY. The camera/periscope assembly consists of an O-15 camera, a beam-splitting periscope, and a 35-mm film magazine installed on the navigator's radar indicator (Figure A-1). The beam-splitting periscope allows the navigator to view the radar indicator while the imagery is being recorded on 35-mm motion picture film. The output of the system is a negative-image 35-mm motion picture film strip which provides the radar imagery and auxiliary data recorded on each frame.

3. AUXILIARY DATA BLOCK. The standard O-15 data block has been replaced with an insertable auxiliary data block which consists of a bank of light-emitting diodes (LEDs). This component is capable of providing 20 items of auxiliary information. Figure A-2 shows the auxiliary data block in relation to radar imagery. Table A-1 lists the auxiliary data codes and a description of each.

4. OTHER COMPONENTS. Other components consist of a keyboard entry control, LD-6 camera control (Figure A-3), power supply (Figure A-4), and several junction boxes (Figures A-3 and A-5).

Table A-1. Auxiliary Data Codes and Descriptions.

Code	Description
DAY	Julian date
YR	Last digit of year
NAME	Navigator's coded name
DZ	Drop zone number
HR	Hour of day (24-hour clock)
MIN	Minute
SEC	Second
MH	Magnetic heading
GS	Ground speed
TAS	True airspeed
TA	Track angle
CM	Cursor motion
R	Radar range
C	Compass being used
MSLALT	Mean sea level altitude
CAZ	Cursor azimuth
CR	Cursor range
RU	Radar update
W	Warning control
OA	Offset aiming point

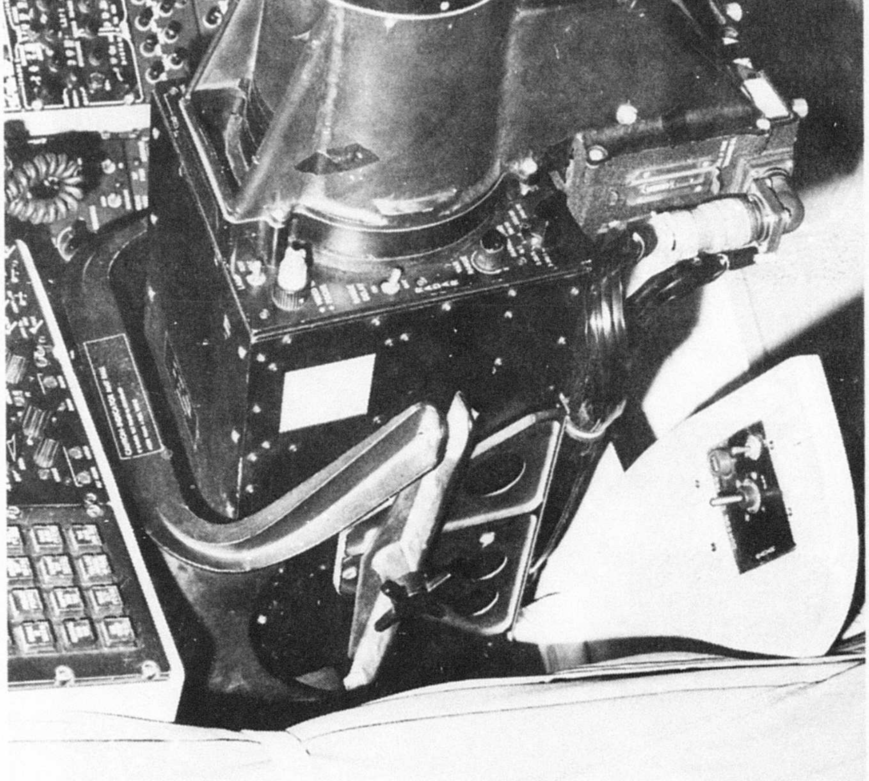

Figure A-1. Camera/Periscope Assembly.

Figure A-2. Radar Imagery and Auxiliary Data Block.

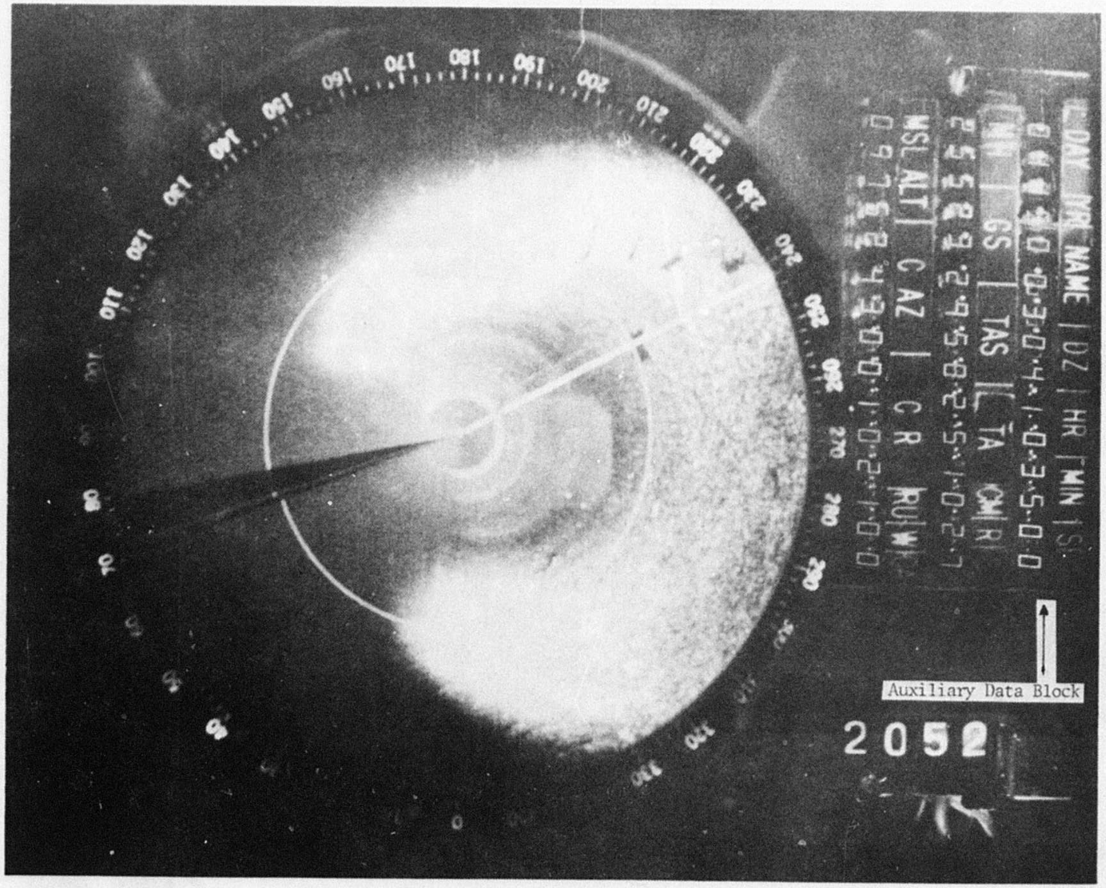

Figure A-3. Keyboard Entry Control, LD-6 Camera Control, and Junction Box A.

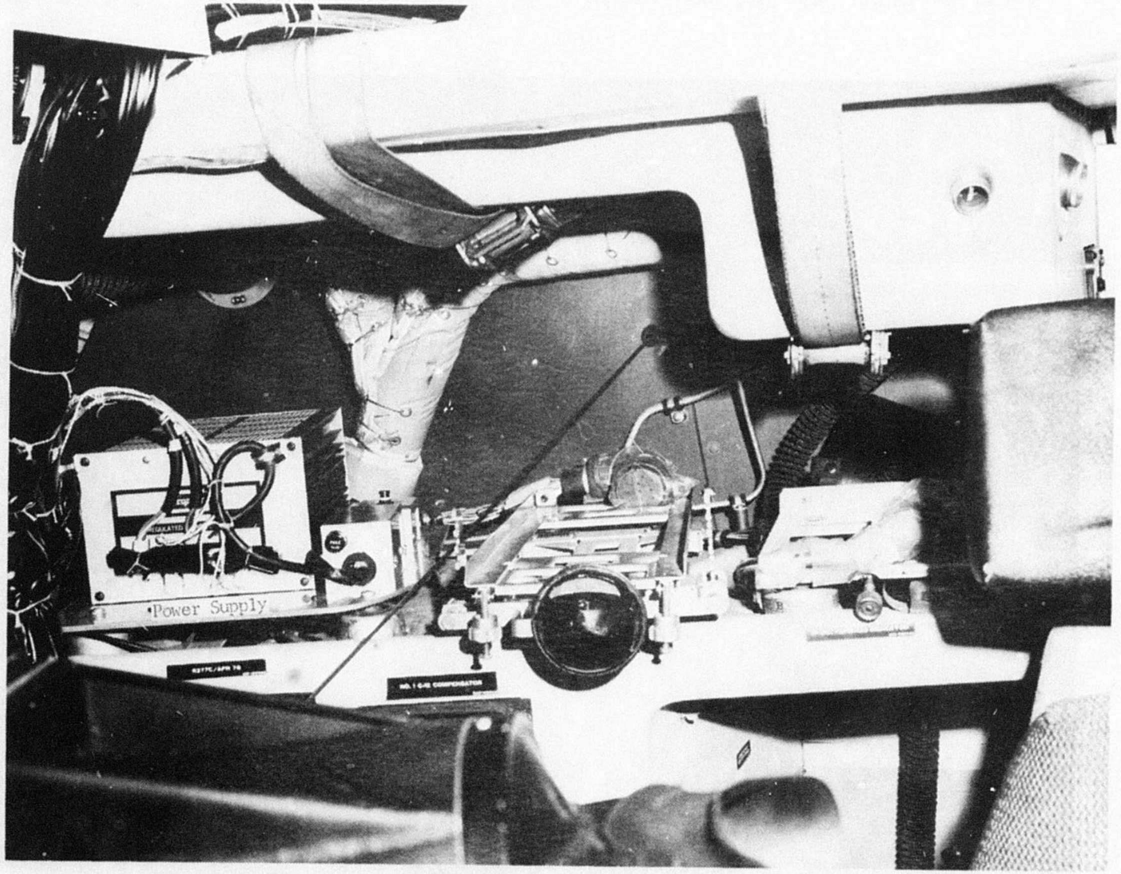

Figure A-4. Power Supply.

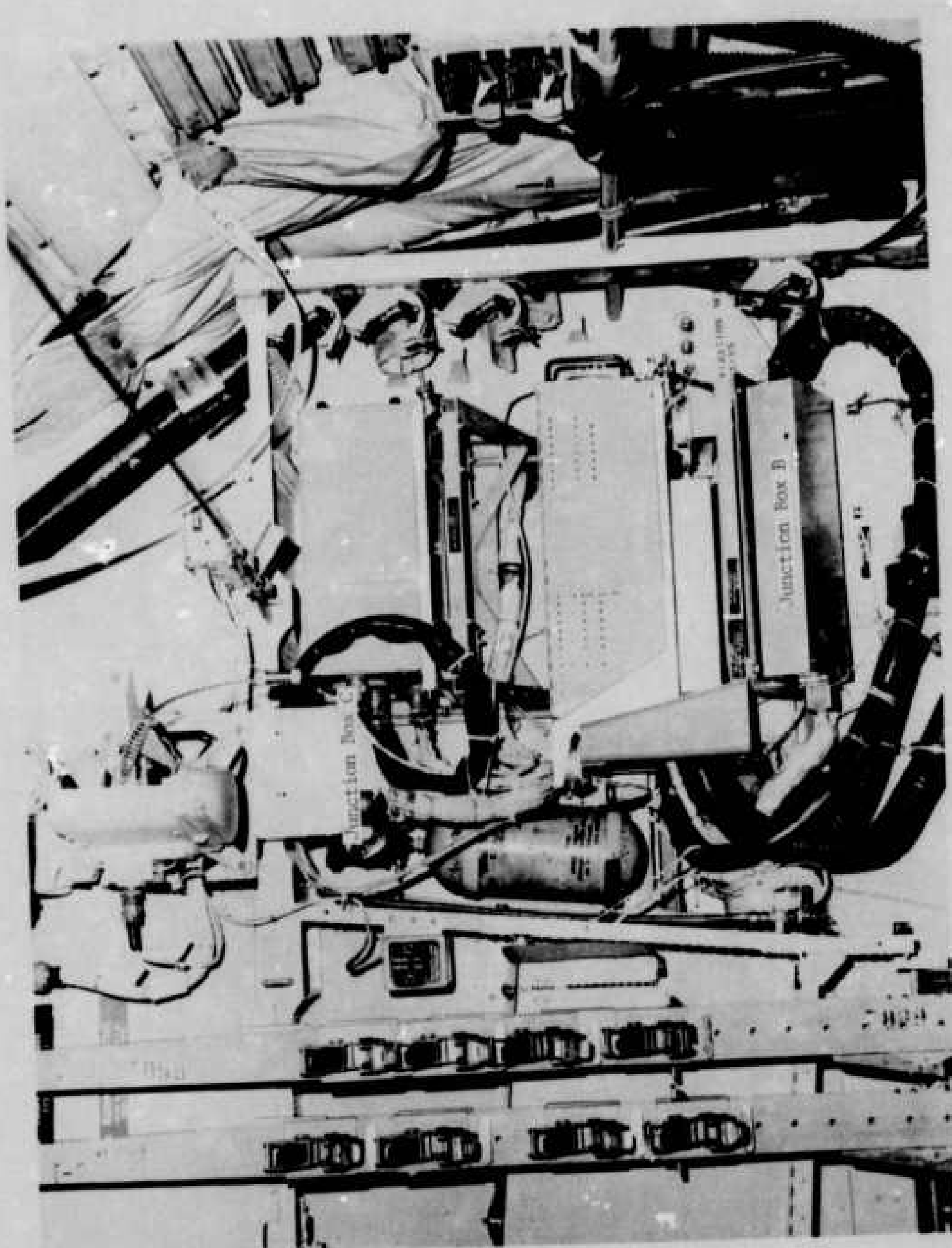

Figure A-5. Junction Boxes.

ANNEX B

OPERATING INSTRUCTIONS

1. This annex contains preliminary instructions for the operation of the prototype radar imagery recording system.

2. The following is a description of actions required to operate the Class II modification and must be used in conjunction with the current AWADS C-130 checklists.

a. At Aircraft.

(1) Record film footage as indicated on magazine.

(2) Install loaded film magazine.

b. LD-6 Control (Figure B-1).

(1) Turn selector switch to EVERY SCAN.

(2) Turn power switch to OFF.

(3) Record the O-15 camera frame number.

c. Keyboard Entry Control (Figure B-2).

(1) Turn power switch to ON.

(2) Load top line of data block information as follows:

(a) Push test LEDs button; all digits should illuminate as eights. Record any void digits or segments.

(b) Release test LEDs button; the digits below DAY, YR, NAME, and DZ will all turn to zero. An erroneous time will appear on the running digital clock (HR, MIN, SEC).

(c) Push the DAY-YR keyboard button; the DAY-YR light will illuminate.

1. Enter the appropriate Julian date and year; for example, Saturday, 19 October 1974, is the 291st day, 4th year (291/4).

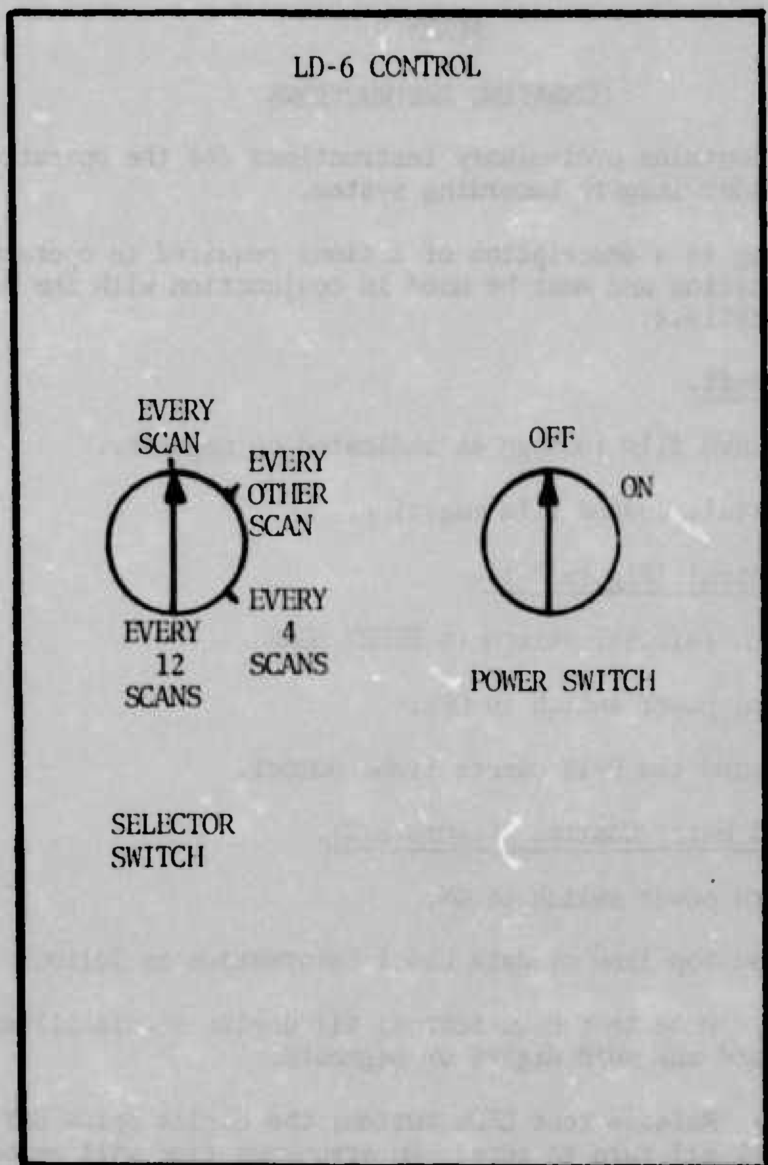

Figure B-1. LD-6 Control.

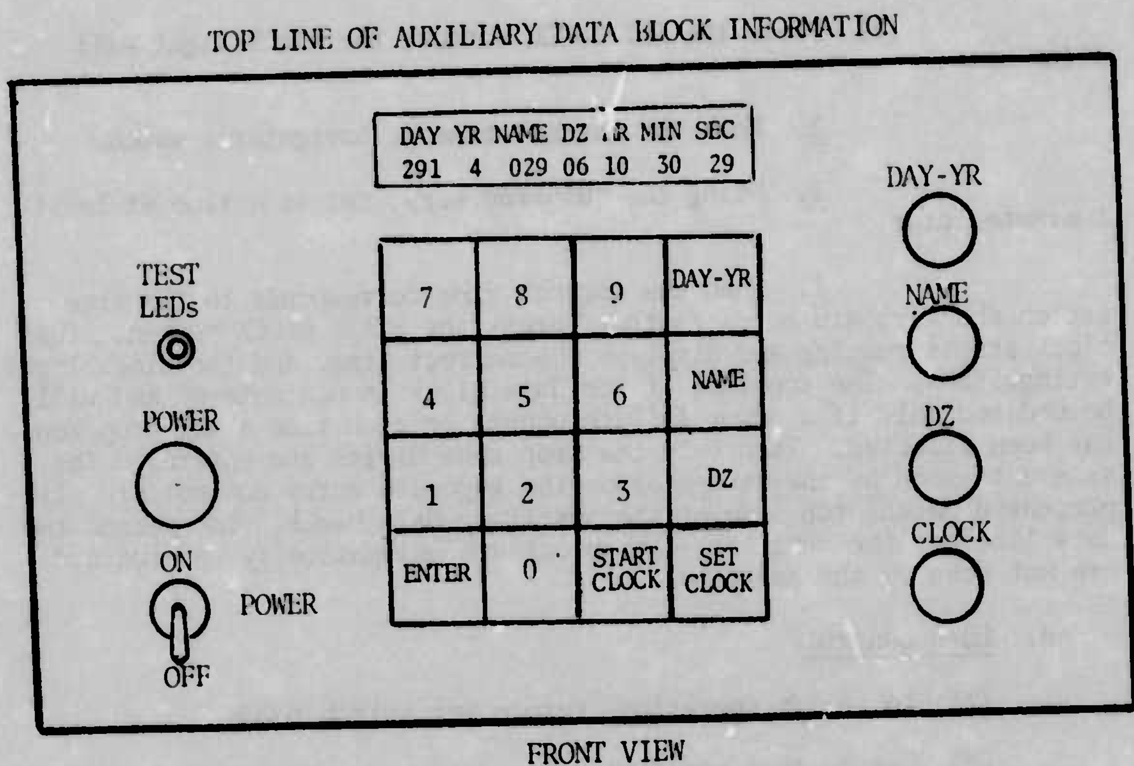

Figure B-2. Keyboard Entry Control.

2. Press 2, 9, 1, and 4; and 291/4 will appear in the DAY-YR display.

3. Press the ENTER button to enter the data into the computer. The DAY-YR light will extinguish.

(d) In a similar manner, set in the coded navigator's name and drop zone.

(e) Press the SET CLOCK button; the clock light will illuminate.

1. Note the correct time on navigator's watch.

2. Using the numbered keys, set in a time at least 1 minute later.

3. When the correct time corresponds to the time set on the keyboard entry control, press the START CLOCK button. The clock starts running and displays the correct time, and the clock light extinguishes. The top line of the data block is now entered and will be updated only if a power failure occurs or each time a new drop zone has been selected. Then only the drop zone digits are entered. The same data seen by the navigator on the keyboard entry control are also presented on the top line of the auxiliary data block. The second two data lines of the auxiliary data block are automatically updated and are not seen by the navigator.

d. LD-6 Control.

(1) To verify operation, turn power switch to ON.

(2) Verify that red film spool drives on the magazine are turning.

NOTE: A 3-second timer has been added to the O-15 camera installation, which will force a minimum of 3 seconds between film exposures. This was done to extend the mission coverage time and to reduce redundant film exposures with little overlap.

(3) Turn power switch to OFF.

e. After Takeoff. Turn LD-6 power switch to ON.

f. Before Landing.

(1) Turn LD-6 power switch to OFF.

(2) Turn keyboard entry control box power switch to OFF.

g. After Landing.

(1) Record O-15 camera frame number.

(2) Remove film magazine from camera.

(3) Record film footage as indicated on magazine.

NOTE: Do not open film magazine.

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Adverse Weather Aerial Delivery System (AWADS)
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Imagery Recorder
Keyboard Entry Control
O-15 Camera

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

MAC Project 74C-110U was conducted to evaluate the prototype adverse weather aerial delivery system radar imagery recorder. The primary purpose of the project was to determine the operational effectiveness and suitability of the prototype system for use in navigator ground training, radar prediction, and reconnaissance/intelligence gathering.

It was concluded that the prototype system is operationally effective and suitable for use in navigator training and radar prediction and has limited

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capability as a reconnaissance/intelligence-gathering device. The system provides imagery of such quality that radar returns for use as en route checkpoints and target area offset aiming points are readily identifiable. The navigator-operated controls for the recorder system are operationally suitable; however, the system in its present configuration hinders normal operations. The prototype system records sufficient information to identify aircraft position from the reproduced image and is capable of operating at altitudes up to and including 25,000 feet above mean sea level with the aircraft both pressurized and unpressurized.